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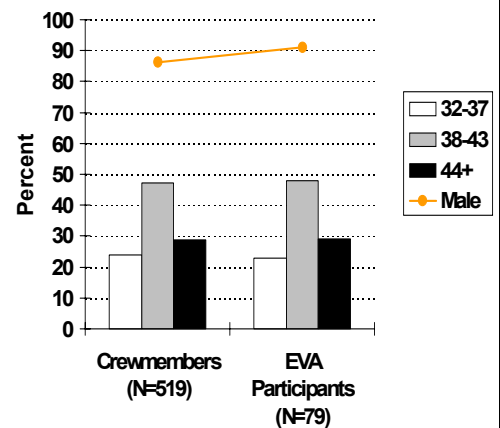
An Update on the Physiological Variables of EVA Participants

The physiological variables of extravehicular activities (EVA) participants were first explored in the October 1998 issue of the LSAH Newsletter. This initial article investigated EVA participants within the Shuttle program, up to January 1998. Between then and December 2001, 26 additional EVAs within 12 missions have been performed. All but three of these EVAs were performed in support of assembly and maintenance of the International Space Station. As this assembly and maintenance process is a continual one, many more EVAs will have to be performed in the future. The following is an updated look at EVA astronauts, to see if the increased number of participants leads to observations different than previously noted. As before, this analysis compares physiological variables between astronauts who have flown in space (*i.e.*, crewmembers) and those who have performed EVAs.

Currently, 312 individuals have been selected into the NASA astronaut corps. Of these, 197 have flown in the Shuttle program through the launch of STS-108 on December 5, 2001. Within the same time period, approximately 109 EVAs have been performed. In analyzing the data, each mission is counted as an individual event for both Shuttle astronauts who have flown and EVA participants. Therefore, one astronaut may count for more than one crewmember, and be in more than one age group. Through December 2001 there have been 536 NASA crewmembers, with 79 EVA participants.

Of the Shuttle crewmembers, 519 had available data from the annual examination closest to, and before, their missions. Their gender distribution shows that 86.4% are males (Figure 1). Almost half

Figure 1. Age and Gender Distribution of Astronaut Groups at Time of Examination



of these crewmembers were between 38 and 43 years of age, making this age group the largest subset. About 70% of the entire group was younger than 44 years of age.

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What is Evidence-Based Medicine?

Evidence-Based Medicine (EBM) is the practice of integrating clinically relevant research with patient care. The use of best research evidence in a medical practice may seem to be an obvious component of good clinical care. Indeed, the concept of EBM is not new; some trace the origins of this concept back to post revolutionary France. What EBM establishes is a formal structure for critical review and application of research to patient care. The modern definition of EBM was

developed in the early 90's, and international interest in it has grown since. According to the Centre for Evidence-Based Medicine, there are now at least 6 evidence-based journals, published in at least 6 languages, that summarize the most relevant studies for clinical practice.

The practice of evidence-based medicine typically involves the following steps:

- Converting clinical care need into focused questions – the information need encountered in caring for

the patient (*e.g.*, prevention, therapy, etc.) is distilled down into specific, answerable questions.

- Finding the best evidence to answer the question – track down the most current clinical research providing the best answer to the question. This involves weighing evidence obtained using different study designs such as randomized clinical trials, prospective cohort

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Table 1 shows the means of the following variables for the Shuttle crewmembers: age (at time of examination), BMI, percentage of body fat (% Body Fat), mean

VO₂max and maximum heart rate (MHR). BMI and percentage of body fat provide measures of fatness for the group.

BMI, which is more

accurate for a group of people than for an individual, is calculated by dividing the weight (in kilograms) by the squared height (in meters). A BMI between 22-26 for both men and women is about standard. Percentage of body fat is an estimation of fatness based on the sum of three skin-fold measurements and age at last birthday. Values of 10%-15% for men, and 20%-25% for women, are considered to be the norm for the general population. VO₂max and MHR are estimations of cardiovascular fitness that are measured during an Exercise Tolerance Test. VO₂max is measured by the volume of oxygen, in milliliters per kilogram of body weight, expired per minute, and is an indicator of an individual's maximal aerobic capacity. A higher value indicates a higher aerobic capacity. The normative values of VO₂max for men and women in good aerobic condition in the 30-49 years age group are 41 ml/kg/min and 37 ml/kg/min, respectively. The MHR is measured in beats per minute, and lower values are more desirable. For individuals in the 38-49 years age group, the expected MHR is 179.7 beats per minute. As expected, the crewmembers showed better fitness than the general population. The majority of the crewmembers, those in the 30-43 year age group, had higher VO₂max and lower MHR values than the previously mentioned norms.

As with the crewmembers, each EVA per mission is accounted for, so that an astronaut is counted for every EVA mission and the age group s/he has achieved. All 79 EVA participants had

Table 1. Shuttle Crewmembers

Age Group at time of exam	N	BMI	N	% Body Fat	N	VO ₂ max	N	MHR
32-37	124	23.6	181	15.1	183	46.5	174	177.6
38-43	245	24.2	183	16.5	187	43.0	178	172.1
44+	150	24.9	119	18.4	119	41.7	106	169.9

Table 2. EVA Participants

N of Age Group at launch	Age Group at time of exam	N	BMI	N	% Body Fat	N	VO ₂ max	N	MHR
16	32-37	18	24.6	22	14.3	22	48.9	21	174.7
39	38-43	38	24.4	25	16.5	25	41.4	24	172.6
24	44+	23	24.1	17	16.2	18	41.0	17	164.3

data available from examinations closest to and before their missions (Table 2). The majority (70.9%) of the EVA participants were under the age of 44, and 91.1% of them were male (Figure 1). The small number of female participants precludes data analysis of this subset.

All of the parameters varied only slightly between EVA participants and Shuttle crewmembers. The largest age group representation for both EVA participants and crewmembers is in the 38-43 years age group (48.1% and 47.2%, respectively). In comparing the majority of each group's subjects (38-43 years age group), there is very little difference in the BMI, average percentage of body fat, or mean MHR between the two age groups. When these values are compared in terms of aging trend, EVA participants – unlike Shuttle crewmembers – did not show the expected trend of increasing BMI, increasing percentage of body fat, and decreasing VO₂max in progressing from the younger to older age groups. This may mean that EVA participants maintain better overall fitness within the older age group than crewmembers as a whole. However, the small age group subsets of this sample may also affect their mean values.

There is little difference in the age makeup between the Shuttle crewmembers and EVA participants. The majority of crewmembers and EVA participants also have very similar fitness levels, as shown in the small

difference in the physiological variables values between the two groups. The difference in aging trend between the two groups may indicate that EVA training facilitates maintenance of aerobic fitness for the crewmembers. As the entire astronaut corps ages, and more EVA data accumulate from the maintenance and assembly of the ISS, a more comprehensive analysis can be performed to substantiate this observation. ■

EVA Facts

36: number of minutes spent by Edward White in the first US spacewalk on June 3, 1965, during the Gemini 4 mission.

22: number of years between US EVAs outside a space station. Gerald Carr and Edward Gibson performed the last Skylab EVA on February 3, 1974 during the Skylab 4 mission, while Michael Clifford and Linda Godwin installed the Mir Environmental Effects Payload to the Mir Docking Module during the STS-76 mission on March 27, 1996.

160: approximate number of spacewalks scheduled from 1998 to 2005 to assemble, outfit and begin research use of the International Space Station, spanning 37 space shuttle missions.

Safety Tips for Walkers and Runners

A healthy lifestyle is incomplete without the incorporation of physical activity. The ease and convenience of jogging/running and walking have made these activities two of the most popular among novices and professionals alike. According to the LSAH Lifestyle Questionnaire (LSQ), 72.3% of the responding 220 NASA astronauts and 38.2% of the responding 781 LSAH comparison participants list jogging/running among their various physical activities. Of the responding 32,440 National Health Interview Survey 1998 (NHIS) participants, 10.6% choose jogging/running among their various physical activities. In addition, 24.5%, 49.2%, and 43.2%, respectively, choose walking among their various physical activities (Figure 1). The LSQ was developed in 1993 to collect essential health data on NASA astronauts and LSAH comparisons that were not otherwise collected. The NHIS includes health data on a random selection of non-institutionalized U.S. civilians over the age of 18.

With added physical activity comes an increased risk of injury. The following

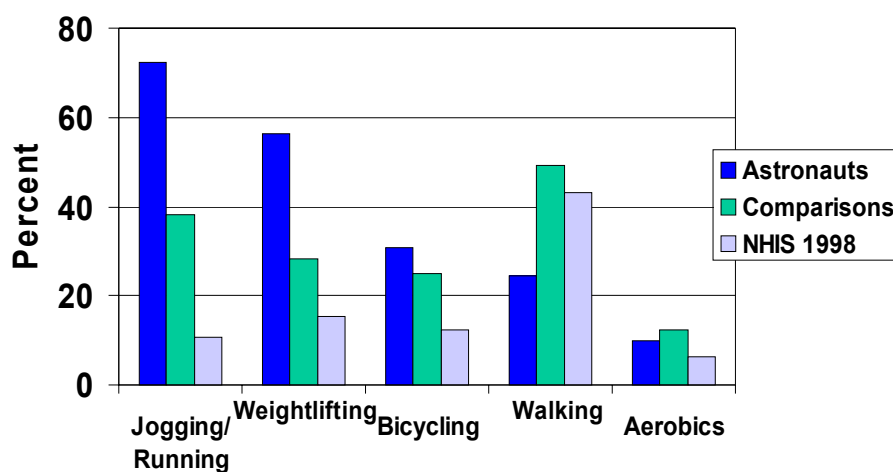
safety tips should help reduce these risks and lead to a successful exercise session.

- **Consult a medical professional.** A successful exercise program begins by consulting your personal physician, who can help tailor a program that is appropriate for your age, health status, and fitness goals. Other resources include the JSC Health Related Fitness Program offered to every JSC employee, and the Astronaut Strength, Conditioning and Rehabilitation Program for astronauts.
- **Warm-up and cool down.** The exercise session should begin by warming up the body and gradually **increasing** the heart rate. The session should end by cooling down the body and gradually **decreasing** the heart rate. A simple 5-minute warm-up session should consist of small movements that raise the body's temperature approximately 1 degree. This decreases the amount of stress placed on heart and other muscles of the body.
- **Stretch before and after the exercise session.** This can help prevent and

speed the recovery of small tears in the muscles and other injuries that may have occurred during the workout. Traditional stretches should be performed after both the warm-up and cool-down. It may also be beneficial to stretch during a strenuous workout as well.

- **Breathe.** Oxygen is essential for respiration, the exchange of gases that occurs in all of the body's cells. The more active you are, the more oxygen the body needs. Accordingly, participation in physical activity involuntarily requires us to breathe more rapidly than we would when at rest. So make a conscious effort to take full breaths before, during, and after the exercise session.
- **Drink plenty of water.** Six to twelve ounces of fluid can be lost for every 20 minutes of running. The American Academy of Orthopaedic Surgeons recommends drinking 10-15 ounces of fluid 10 to 15 minutes prior to running and every 20 to 30 minutes thereafter.
- **Choose the proper attire.** Layer loose-fitting clothing that is appropriate for the weather. In cool weather, desired attire consists of an inner layer that takes perspiration away from the skin, an absorbent middle layer, and a windbreaker for the outer layer. In warm weather, exercise in the shade, apply a sunscreen with a sun protection factor (SPF) of at least 15, and protect your eyes from harmful UVA and UVB rays by wearing sunglasses and a hat. Choose a proper exercise shoe that stabilizes and cushions the foot. Be sure to leave a thumbnail's width between the tip of the shoe and the longest toe. Avid runners should replace their shoes at least once a year to ensure the required shoe performance.

Figure 1. Top 5* Reported Physical Activities



*Top 5 reported physical activities that were uniformly collected for both the LSQ and the NHIS. This excludes all other sports, gardening, stretching exercises, and stair climbing. The categories are not mutually exclusive.

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Medical Information Resources

So where do you turn to if you want to get more information on a disease or disorder? Here is a short list of information sources:

- ◆ Your healthcare provider (physician, nurse, or the patient education department at your local hospital).
- ◆ Community or medical library. The former provides a good starting point, while the latter provides more specific and technical resources. Medical resources can be found at medical or nursing schools or large medical centers.
- ◆ Services provided by the federal government and other organizations. The National Health Information Center provides a list of Federal information clearinghouses on their website (www.health.gov/nhic), or through written and voice inquiries (P.O. Box 1133, Washington, DC 20012-1133 or 800/336-4797).
- ◆ Computer databases such as Medline or CHID (Combined Health Information Database), available at www.nlm.nih.gov, and chid.nih.gov, respectively. ■

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- **Avoid exercising alone.** If you must, let others know where you will be exercising. Carry identifying information that includes your name, phone number, and medical information. This information can easily be carried on an identification card or by writing it on the inside sole of your shoe.
- **Choose clear, even, soft exercise surfaces.** This will help prevent falls and reduce excessive stress on the joints.
- **Wear reflective clothing when exercising at dusk or dawn.** Avoid exercising at night.
- **Treat injuries with the RICE method.** Exercise related injuries can be reduced by following the previous safety tips and by being aware of the exercise environment. Sore muscles are common when beginning an exercise program; however, if the pain or soreness persists, then a significant injury may have occurred. The RICE method—Rest, Ice, Compression, and Elevation—should be used as the first form of treatment. Rest to prevent further injury. Ice the injured area to reduce any swelling and internal bleeding. Apply compressions, such as an elastic bandage, to help reduce the swelling. Elevate the injured area so

that it is higher than the heart. This will limit fluid accumulation. Finally, don't hesitate to seek medical attention as needed. ■

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- studies, or meta-analyses.
- Critically appraising the evidence for its validity and applicability – judge the soundness of the studies' design and result, and determine their usefulness to the clinical questions.
- Applying the evidence to clinical practice – utilize the valid and applicable evidence in tandem with clinical expertise to provide care for the patient.
- Evaluating the effectiveness and efficiency of the process – assess whether: the questions formed were pertinent to the problem, the literature research sought the appropriate studies, suitable critical appraisal measures were used, and integration of research evidence resulted in better clinical care for the patient.

The increasing amount and complexity of today's medical needs underscores the value of evidence-based medicine.

Epidemiology, which studies the distribution and determinants of disease frequency in human populations, forms an ideal base for EBM practice. By having a sound understanding of epidemiological principles, clinicians can improve their review of available evidence, critical appraisal of studies, and their relevance to the clinical needs of the patient. The Longitudinal Study of Astronaut Health applies epidemiological principals in its investigation of risks associated with astronaut occupational exposures, making it the primary support for the EBM initiative here at the Johnson Space Center. ■

For your information

If you want a copy of your exam results, please complete and sign a release form while you are visiting the Clinic for your examination. The form is called *Privacy Act Disclosure Authorization and Accounting Record (DAAR)*, or NASA Form 1536.

...and ours

If you have a new address or phone number, please let us know by calling (281) 244-5195 or (281) 483-7999. You may also write us at:

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